Shanghai: from 'Black and Stink' to clean Suzhou Creek

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Summary

Suzhou Creek flows through Shanghai, one of the world's largest mega-cities. During the 20th century, the creek fell victim to rapid urbanisation, swallowing most of the city's waste. In 1996 the 'Economic and Social Development Plan for Shanghai' was adopted, in which the rehabilitation of the creek formed an important component. Due to this 12-year plan to clean up the waterway, Suzhou Creek is no longer an embarrassing, stinky black river. With a number of selected 'no regret' type of projects and measures the Shanghai Municipal Government has been very successful in quickly cleaning up Suzhou Creek.

One of the major factors contributing to the success of the Suzhou Creek rehabilitation project has been the institutional arrangements of the project and particularly the willingness of the various relevant parties to cooperate.

The Shanghai Municipal Government has set a good example of cooperation in the field of water resources and coastal management, and effective decision making in order to enable implementation of such major projects in a relatively short time frame.

Shanghai, view across Huang Pu river to PuDong.
(photo: Peter Kerssens)

1. Introduction

Shanghai, on the Central-East coast of the PR of China, is a good example of the rapid development of many Chinese cities and the challenges this presents to the municipal government. In the last two decades, urban construction activities have skyrocketed, under the pressure of industrial development and large scale urban migration. The latter mainly caused by the need for labour, in industries and business, for the construction of new urban sub districts, office buildings, etc. A new international airport was constructed at PuDong, harbour and activities were relocated from Yangtze river mouth to a new deep sea harbour on YangShan island connected to the mainland by a 32.5 km long bridge. The infrastructure in and around the town was wholly upgraded to international standards. For instance, a sky train was built between PuDong airport and the city, while Nanjing and Hangzhou were connected with high speed railways. An extensive road system was constructed through and around Shanghai and its suburbs, new tunnels and bridges were made to connect the city with PuDong as well as Chongmin island, and a whole new metro system was developed within a relative short period.

In PuDong, on the other side of the HuangPu river, a complete new Commercial and Business district was built and has been in operation for 10 to 15 years. Now Shanghai is not only a centre of industry and commerce, but also the gateway to the Chinese hinterland for goods moving up and down the Yangtze river. Moreover, it has become a major player in the banking and financial sector in East-Asia.

Apart from the rapid urban developments described above, Shanghai has not neglected the socio-economic and cultural aspects that go parallel with such activities. In their desire to become a world-class city, they have paid considerable attention to cleaning up their environment, and to upgrade the service in the water supply and sanitation sector. New sewerage systems, as well as a number of wastewater treatment plants were built, while several new drinking water intake, storage and conveyance systems were constructed in and along Yangtze river and Tai lake.

With regard to culture, a new Shanghai Museum was built meeting the highest international standards, opera and musical facilities were provided and/or expanded, and the arts sector is flourishing, with regard to both architecture, film, music and other visual arts. In the field of sports, new stadiums and an international Formula 1 racetrack have been constructed and are intensively used.

2. Suzhou Creek Rehabilitation project

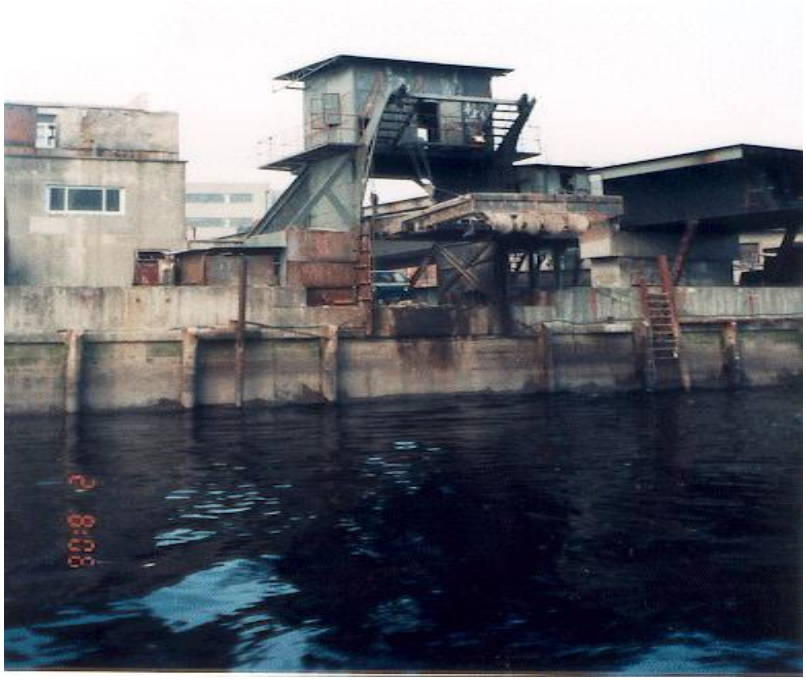
In the middle of the nineties, the Shanghai Municipal Government (SMG) realised that the condition of Suzhou Creek (SC), running from Tai lake right through the heart of the city to Huangpu river, did not meet environmental standards and was unacceptable for healthy living. A valuable database was created and contained the point sources of pollution, about 3,300 sources from factories, hospitals, restaurants, hotels are located in the Suzhou Creek area (Figure 3).
In February 1996 SMG's People's Congress adopted the 'Economic and Social Development Plan for Shanghai' for the period 1995-2000 and up to 2010. In this plan, the rehabilitation of SC was one of the city's most important projects to meet its environmental development goals. With full backing of the central government, the rehabilitation of Suzhou Creek was considered essential for the further development of Shanghai into a global city.

Suzhou Cree, before the era of pollution.
(photo: Peter Kerssens)

The original Plan stated, amongst other things, that before the year 2000 :

"The present sewage system SSP-I should be improved and modified as perfectly as possible; interception and collection of all industrial waste (water) along Suzhou Creek (SC) should be completed; direct pollution of SC from domestic waste loads should be stopped; and all engineering measures should be taken to change the presently 'black and stink' areas into domestic living conditions meeting the accepted standards of the People's Republic of China."

The Shanghai Municipal policy allowed for a rehabilitation period of the SC area of 15 years, after which the area should become a financial/business *cum* residential area, providing medium/high class living conditions, meeting the national PRC water quality standards, and providing the proper environment for tourism purposes. This called for a concerted action to improve the water quality conditions in SC in two stages, to meet water quality Class V standard in the city between 1997 and 2000, and Class IV between 2000 and 2010.



Black and Stink in Suzhou Creek in the early 1990s. *(photo: Simon Groot)*

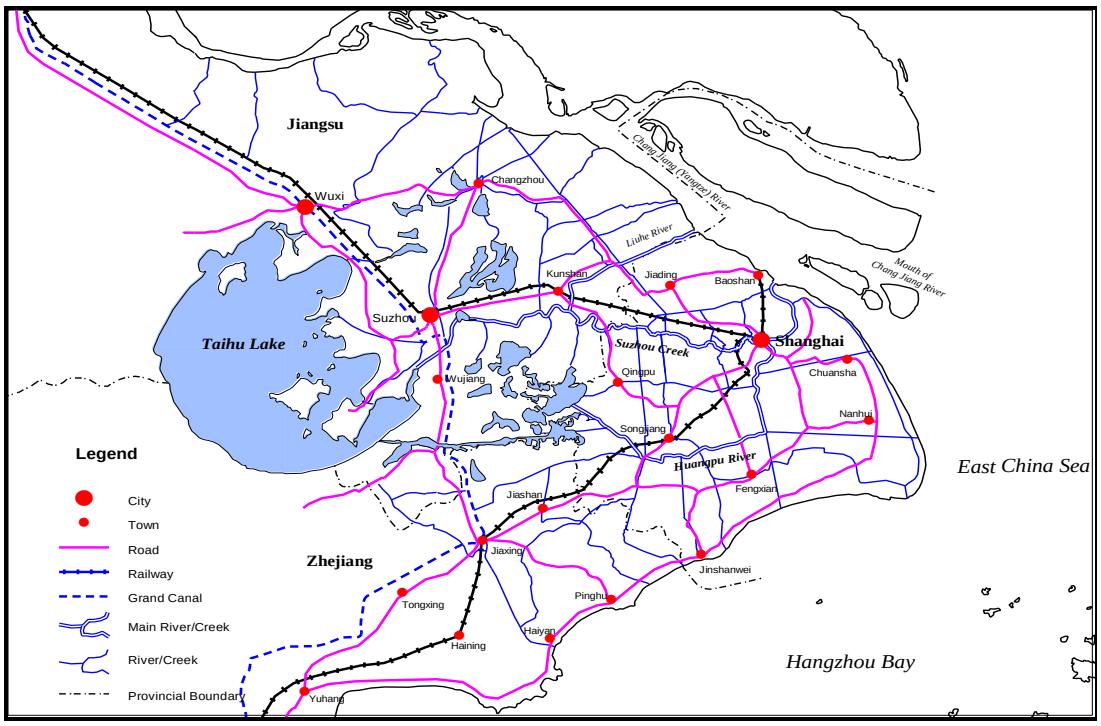


Figure 1 : ***Project area with main infrastructure.*** *(source: Delft Hydraulics and AEA Consultants, 1998)*

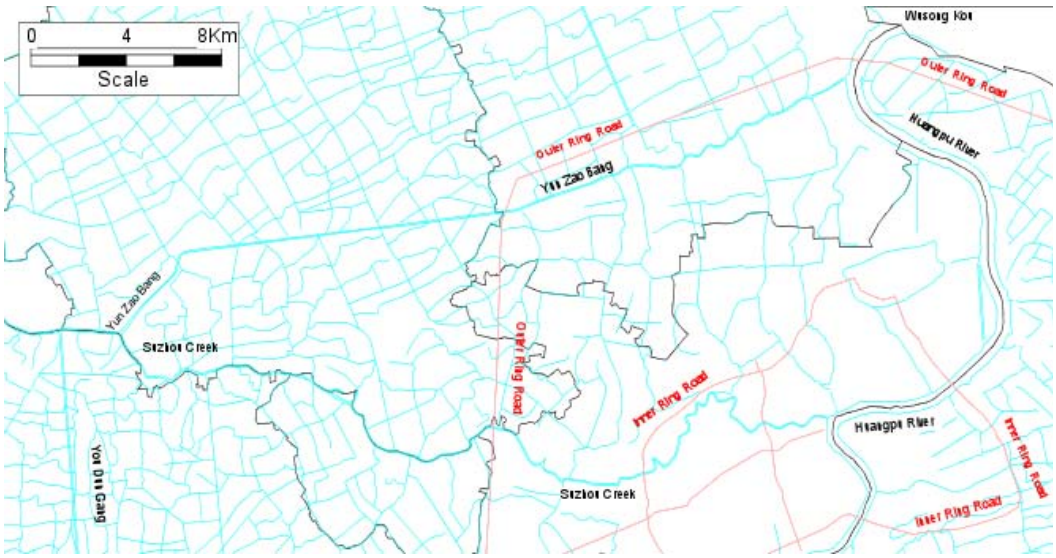


Figure 2 : ***Water Resources (detailed) system Shanghai city.*** *(source: Delft Hydraulics and AEA Consultants, 1998)*

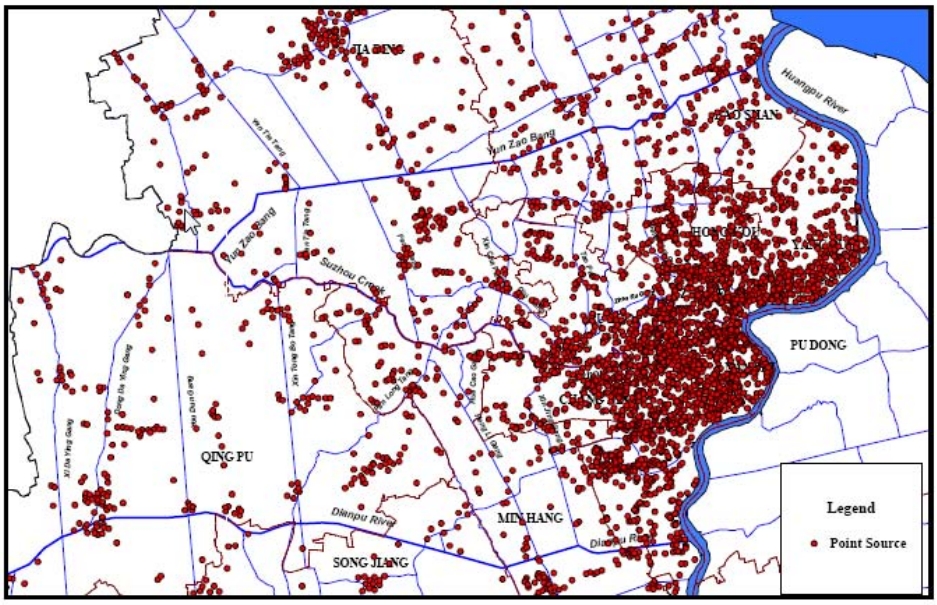


Figure 3 : ***Registered point sources of pollution*** *in the Suzhou Creek Project area. (source: Delft Hydraulics and AEA Consultants 1998)*

3. Project Activities of the Suzhou Creek Rehabilitation project

Early in 1997, the Asian Development Bank (ADB) granted an advisory technical assistance to the Government of China to help the Suzhou Creek Rehabilitation Project in Shanghai to prepare a comprehensive plan for water quality management (WQM) for the Suzhou Creek. The assistance was provided by a combination of international and local consultants, being Delft Hydraulics (now DELTARES) from the Netherlands as leading partner, in association with AEA Technology from the UK, and a variety of Chinese institutes, bureaus and universities providing the local consultancy. The major task was to compose an improvement plan for the immediate clean up of Suzhou Creek, at that time being a dirty, black and stinking river.

The studies mainly concentrated on three different types of measures to fulfil this goal. Firstly, the water resources components: through flow diversion and augmentation measures, and dredging polluted sediments from the bed, the water quality of Suzhou Creek and its tributaries should be improved in the short term. Secondly, the water management components: the interception of sewage in the city districts draining into Suzhou Creek and its tributaries

should be created by the construction of sewerage projects, e.g. the Shanghai Sewerage Project, combined with wastewater treatment plants.

Finally, a number of urban renewal measures should be carried out, covering the removal of garbage and night soil landing sites along the Creek, rehabilitation of the floodwalls, construction of parks and boulevards, etc. In Table 1 an overview is given of the various components of the plan and its detailed projects and measures within the individual components/packages.

Table 1: ***Project components*** *(first stage, 1998 – 2000)*

COMPONENTS	PROJECT TYPE
I. WASTEWATER MANAGEMENT COMPONENTS	• Flow interception • Elimination of WW disposal • WW treatment
II. WATER RESOURCES MANAGEMENT COMPONENTS • FLOW DIVERSION AND AUGMENTATION • WATERWAY REHABILITATION • SEDIMENT AND AERATION MEASURES	• Hydraulic structures • Flow augmentation • Clean-up • Sediment dredging • Re-aeration measures
III. URBAN RENEWAL COMPONENTS	• Embankment reconstruction • Relocation of wharves

4. The results of the Suzhou Creek Rehabilitation Project

In various phases of the Technical Assistance project from Asian Development Bank, a variety of technical and non-technical studies and analyses have been carried out by the consultants, in cooperation with the Shanghai Suzhou Creek Rehabilitation Project Office, assisted by various local bureaus and institutes:

- Waste load management and wastewater treatment;
- Wastewater modelling and water quality analysis, including waste water reduction/ interception and low flow augmentation;
- Environmental impact assessment;
- Social impact studies;
- Institutional analysis;
- Financial/economic analyses;
- Overall project management, final conclusions and recommendations.

One important element was the development of the water quality modelling and Decision Support System (DSS), including databases and computer models, to simulate the flow and the water quality in the system, including the waste load from domestic, industrial and agricultural sources in the districts. This DSS was used to test the effects/efficiency of a number of so called 'no-regret' measures defined to improve the water quality and environmental conditions of Suzhou Creek as quickly as possible. This was based on the requirements of the Shanghai Municipal Government to 'remove the black and stink' before the year 2000.

The measures included the low-flow augmentation and water diversion project, dredging of polluted sediments, flow aeration, and the closure/gate construction in six main tributaries discharging heavily polluted water into the Creek. The DSS was at a later stage also used to assess the efficiency of the sewage interception and wastewater treatment, etc. on the quality of the surface water system. Apart from the technical feasibility, all (10) different project components were also evaluated on their economic/financial feasibility. Finally, the DSS was also used to check the effect of the construction of a new gate at the mouth of Suzhou Creek, resisting high water levels from two directions. However, this was executed as a separate project and not one of the 10 projects in the Suzhou Creek package.

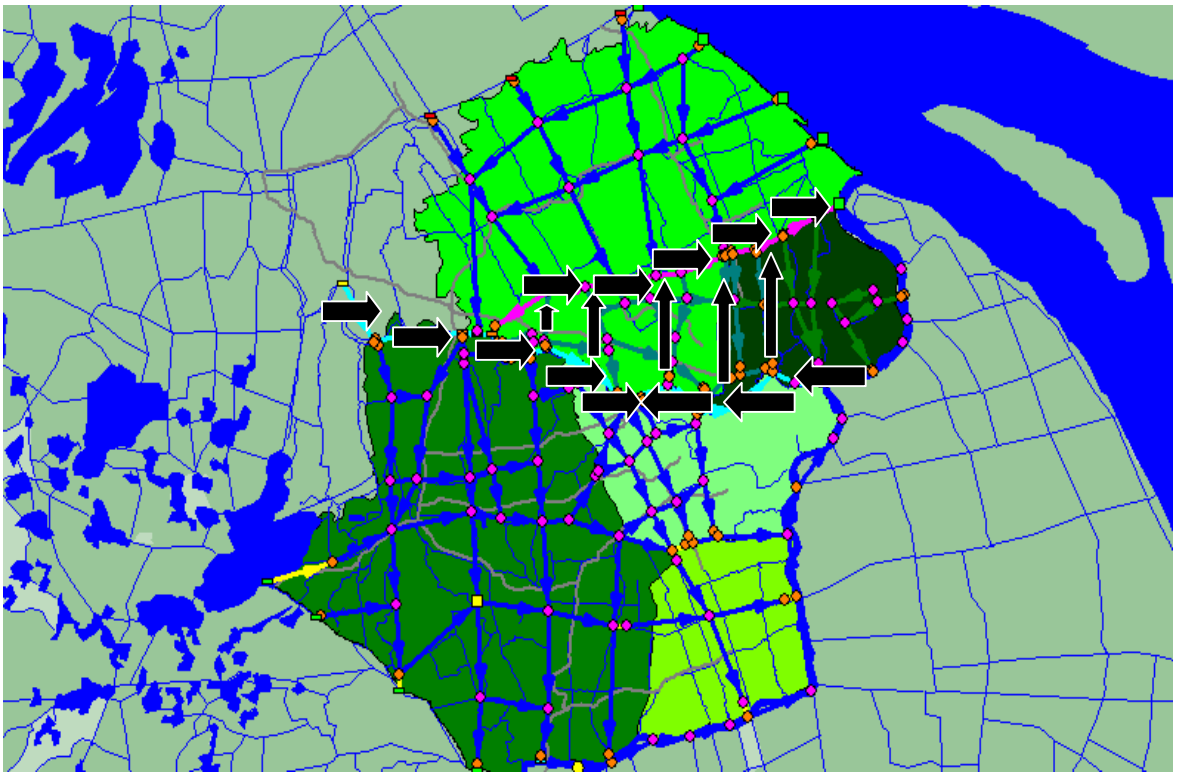


Figure 4: ***Output of the Decision Support System - DSS****: Combined tidal and upland flow flushing scenarios of the Suzhou Creek in relation to the water infrastructure of greater Shanghai area. This DSS combined with the results of the wastewater modelling and water quality analysis provided on overview and the base for a smart flushing scheme and series of rehabilitation measures executed in short period of time.*

The measures designed during the first study phase and tested with the DSS system turned out to be quite effective. Using the DSS the most promising scenarios were developed and during the second study phase some of the measures were implemented.

The scenarios analysed with the DSS (see also Figure 4) were as follows:

- Base case (present situation);
- East-North flushing (previously called scenario 1), from Huangpu river through Suzhou Creek to YunZhaoBang, making use of the tidal movement;
- West-East flushing (previously called scenario 2), low-flow augmentation from Tai lake/upper Suzhou Creek, making use of upland discharge;
- Combined: East-North during spring tide, West-East during neap tide periods;
- Combined reverse: East-North during neap tide, West-East during spring tide periods;
- ADTA (Advisory Technical Assistance) : East-North operation on Suzhou Creek , West-East operation/diversion on YunZaoBang, and operate (existing) gates and pumping stations;
- ADTA+: same, with new infrastructure (gates and pumping stations).

Particularly the low-flow augmentation and water diversion project combined with a specific operation of the Suzhou Creek gate at Wusong bridge (ADTA+) turned out to be so successful that the water quality of the Creek substantially improved and the 'black and stink' was gone within about two years. By 1999/2000 many foreign delegations, including the Dutch Prince of Orange in his position of 'water manager', visited the Suzhou Creek Project Bureau and the project organisation proudly took them to Suzhou Creek itself as an example of the very efficient cleanup and the water quality and environmental improvement that had been achieved.

5. Institutional Issues

During the various stages of the Suzhou Creek studies, as well as in other projects/studies related to the Shanghai Water system, an extensive analysis of the institutional conditions regarding water resources in Shanghai was made. An assessment was made of the various parties and stakeholders involved in water resources management, flood management, wastewater collection, transport and treatment, and water quality and environmental control and management (see Figure 5). Multiple discussions were held between the project partners and the various bureaus and institutions with an interest in some part of the water sector and a Tasks, Responsibilities, Activities and Mandate (TRAM) matrix was made up for all relevant parties (see Table2).

From this assessment, it was concluded that the existing institutional conditions were not ideal for an efficient quantitative and qualitative management of the water resources and the water related environment. There was little or no horizontal coordination among the many institutions dealing with water issues. This also put a constraint on the implementation of the Suzhou Creek project and the expected results, since the responsibilities for the specific (sub)projects would be split between the bureaus of Water Resources, Transportation, the Bureau of Urban Construction, and the Environmental Protection Bureau (EPB).

The Municipal Government of Shanghai reacted very quickly and founded the Shanghai Water Authority (SWA). This new organisation integrated the Bureau of Water Resources and parts of the bureau of Urban Construction (as related to sewerage and water treatment) and the Environmental Protection Bureau. Both latter bureaus still exist since their scope is much broader than just water, but the water-related tasks and activities have mainly been concentrated in the SWA. The founding and operations of SWA was considered by all relevant authorities at both municipal and national level as a good and very successful example of institutional change. It has been declared a pilot case for governmental reform in the water sector, combining integrated planning and implementation, water quality and quantity, innovations and infrastructure leading to improving public health increased tourism and recreation.
Beijing municipality has followed this example and other municipalities and provinces are likely to do the same. The experience so far is that SWA is operating efficiently with respect to integrated planning and management of the Shanghai water system and the reform is certainly a success. This also reflects in the implementation of the Suzhou Creek rehabilitation project, the construction of the new Suzhou Creek barrage, and other water related initiatives and investments.

Renewal of Suzhou Creek embankment and flood wall. *(photo: Peter Kerssens)*

6. Conclusions

The success of the Suzhou Creek Rehabilitation project is illustrated by:

- A number of selected 'no regret' type of projects and measures, such as flushing, environmental dredging, re-aeration, and interception of wastewater, the Shanghai Municipal Government has been very successful in cleaning up Suzhou Creek and remove the so-called 'black and stink' in a relative short time.
- The middle- and long term, projects and measures contribute to an even greater reduction of pollutants into the Creek and to a substantial improvement of the water quality. This refers to elimination of wastewater disposal, wastewater treatment, the relocation of solid waste processing wharves, embankment reconstruction, etc.
- One major factor contributing to the success of the Suzhou Creek rehabilitation project has been the institutional arrangements of the project, and the willingness of the various relevant parties to cooperate. In a later stage the governmental reform, i.e. the formation of the Shanghai Water Authority from the bureaus of Water Resources, and parts of the Environmental Protection Bureau and the bureau of Urban Construction, has strengthened the institutional conditions and has contributed to the rapid improvement of Suzhou Creek.

The Shanghai Municipal Government should be complimented for setting such a good example of cooperation in the field of water resources and coastal management, and effective decision making in order to enable implementation of such major projects.

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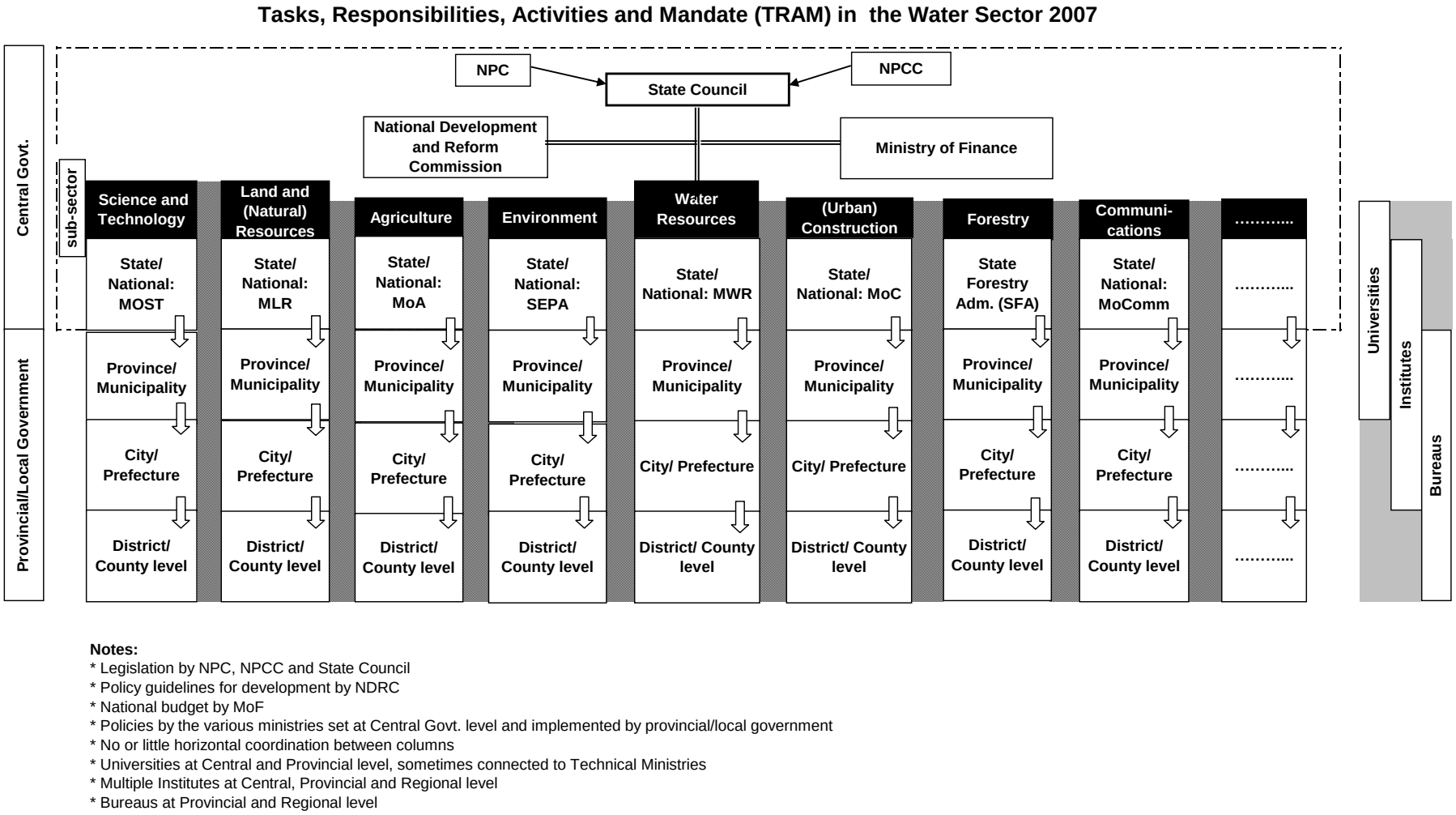

Notes:
* Legislation by NPC, NPCC and State Council
* Policy guidelines for development by NDRC
* National budget by MoF
* Policies by the various ministries set at Central Govt. level and implemented by provincial/local government
* No or little horizontal coordination between columns
* Universities at Central and Provincial level, sometimes connected to Technical Ministries
* Multiple Institutes at Central, Provincial and Regional level
* Bureaus at Provincial and Regional level

Figure 5: ***Institutional setting Water Sector China 2007.*** *(NPC = National People's Committee, NPCC= National People's Consultative Committee)*

Table 2: TRAM Analysis (Tasks, Responsibilities, Activities, and Mandate) - Matrix water sector People's Republic of China

Administrative level ⇓ Water resources issues	County District	City Prefecture	Province Municipality	State National	
Water resources management and conservation, Flood protection, water quality protection	+	++	++	++	Ministry of Water Resources, River Basin Commissions, Bureaus of Water Resources (Conservancy)
Water supply, waste water collection, sewerage and waste water treatment, urban drainage	+	++	++	+	Local Bureaus of Planning, Local Bureaus of Urban Construction, Bureaus of Water Resources
Environmental protection, waste water control, Pollution reduction	++	++	++	++	Ministry of Environment, Provincial and city EPB's
Industrial water use and wastewater control	+	+	++	++	State Development & Reform Commission , Local Economic Commissions, MoE, local EPB's
Agricultural water use, management of agricultural wastewater	+	+	++	++	Ministry of Agriculture/Agricultural Bureaus, MoE and local EPB's,
Irrigation projects/construction	+	+	++	++	Ministry of Construction
Groundwater development and management			+	++	Ministry of Land and Resources River Basin Commissions
Dumping, Marine protection, Resource exploitation			++	++	State Oceanographic Administration Ocean Bureaus
Fisheries management and production	++	++	+	+	Aquatic Products/Fisheries Bureaus
Hydropower development and management		+	++	++	Min. of Land and Resources, Local Bureaus
Inland water transport, depth control Waste from ports and ships	+	+	++	++	Ministry of Communications Bureaus of Communication/Port authorities
Public health	++	++	++	++	Ministry of Health/Sanitation Bureaus

++ large involvement/responsibility + small involvement/responsibility